## A Look Ahead to April, May and June 2011 For the Front Range and the Rest of Colorado

Mike Baker National Weather Service Boulder, Colorado March 25, 2011



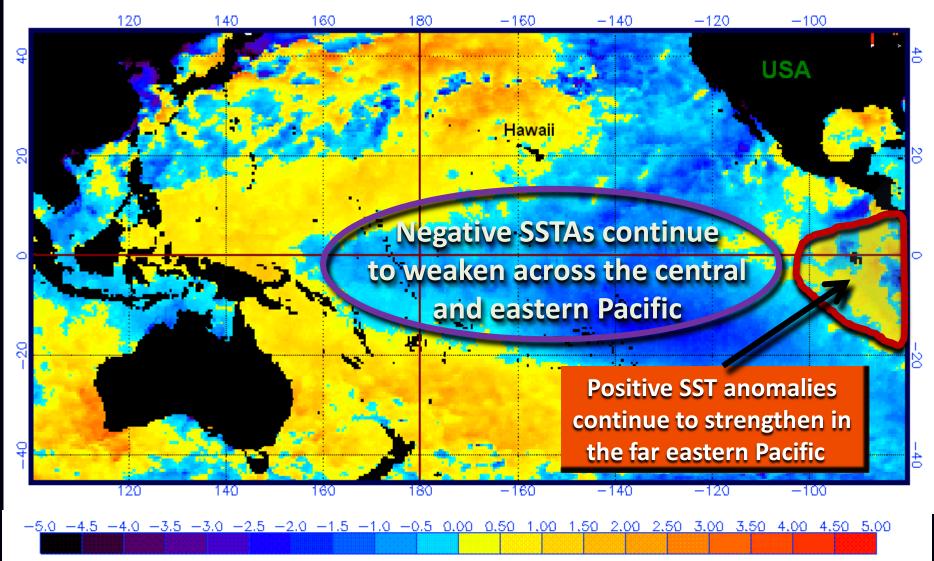


#### **Highlights**

- La Niña conditions in the Pacific continue to weaken.
- The current La Niña has behaved similarly to the last four moderate to strong La Niña events in the past 40 years.
- After a significant cool down across northern and eastern Colorado in February, temperatures have since rebounded with above average temperatures recorded across much of the state during March.
- The western slope of Colorado continues to receive the lion's share of precipitation, largely in the form of snow, which has been produced by a number of moisture laden Pacific storm systems. Whereas areas generally east of the Continental Divide continue to dry out with warm and gusty (Chinook) winds often flowing down the Front Range mountains and out across the eastern plains.
- The latest outlook from NOAA's Climate Prediction Center (CPC) calls for above average temperatures and below average precipitation across most of Colorado the next three months, with the greatest change anticipated on the state's western slope.

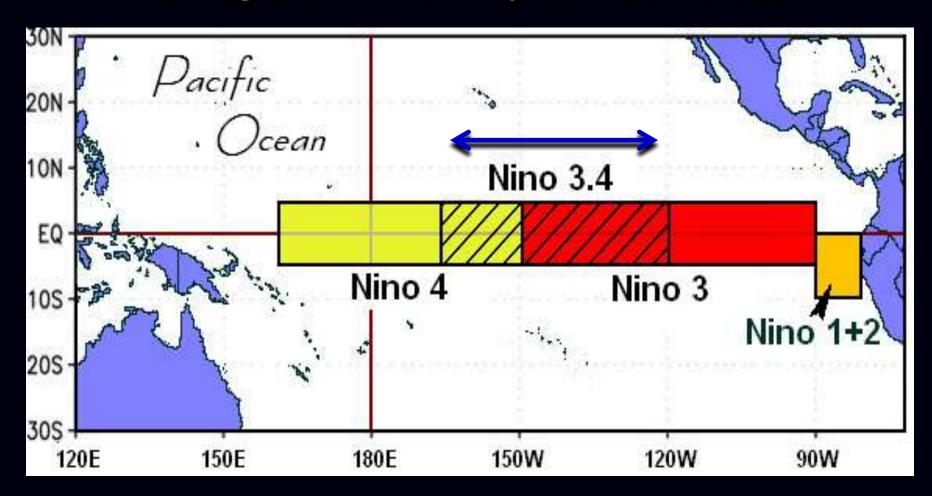


#### NOAA/NESDIS SST Anomalies for the Pacific (degrees C) for Mar 24,2011



Sea Surface Temperature Anomaly (deg C)

#### Niño Regions in the Tropical Pacific Ocean



Nino 3.4 – The principal region in the eastern tropical Pacific used by the Climate Prediction Center (CPC) for monitoring, assessing and predicting ENSO.



Area-Averaged Sea Surface Temperature Anomalies in Degrees C for Pacific Region Nino 3.4 from January 1992 through February 2011

A total of seven El Niños and seven La Niñas of varying strengths have occurred since the winter season of 1991-1992. Noteworthy ENSO events include the strong El Niños during the winter seasons of 1997-1998 and 2009-2010, and the strong La Niñas during the winter seasons 1999-2000 and 2010-2011. The strong La Niña in 1999-2000 fell within an extended period of La Niña conditions that lasted from the fall of 1998 through the spring of 2001.

#### Oceanic Niño Index (ONI)

- The ONI is based on sea surface temperature (SST) departures from average in the Niño 3.4 region of the Pacific and is a principal measure for monitoring, assessing, and predicting ENSO.
- <u>Defined as the three-month running-mean SST departures in the Niño 3.4</u>
   <u>region</u>
- Used to place current events into a historical perspective
- NOAA's operational definitions of El Niño and La Niña are keyed to the ONI index.

#### NOAA Operational Definitions for El Niño and La Niña

El Niño: characterized by a positive ONI greater than or equal to +0.5 C.

La Niña: characterized by a *negative* ONI less than or equal to −0.5 C.

By historical standards, to be classified as a full-fledged El Niño or La Niña episode, these thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons.

CPC considers El Niño or La Niña <u>conditions</u> to occur when the monthly Niño3.4 OISST departures meet or exceed +/- 0.5°C along with consistent atmospheric features. These anomalies must also be forecasted to persist for 3 consecutive months.

#### Oceanic Niño Index - ONI

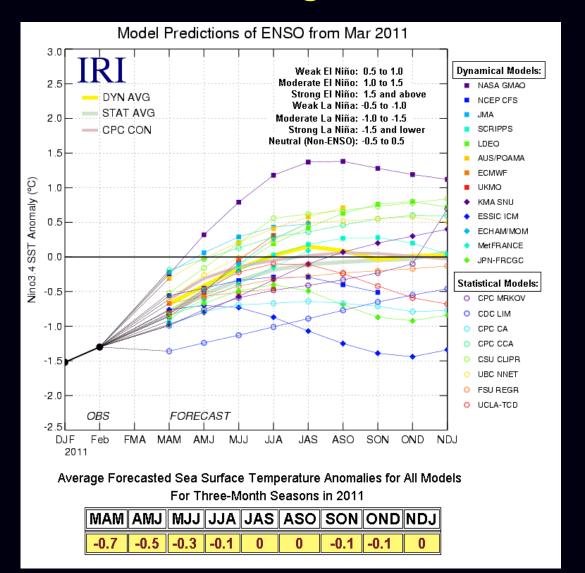
Year	DJF	JFM	FMA	MAM	АМЈ	МЈЈ	JJA	JAS	ASO	SON	OND	NDJ
2000	-1.6	-1.4	-1	-0.8	-0.6	-0.5	-0.4	-0.4	-0.4	-0.5	-0.6	-0.7
2001	-0.6	-0.5	-0.4	-0.2	-0.1	0.1	0.2	0.2	0.1	0	-0.1	-0.1
2002	-0.1	0.1	0.2	0.4	0.7	0.8	0.9	1	1.1	1.3	1.5	1.4
2003	1.2	0.9	0.5	0.1	-0.1	0.1	0.4	0.5	0.6	0.5	0.6	0.4
2004	0.4	0.3	0.2	0.2	0.3	0.5	0.7	0.8	0.9	0.8	0.8	0.8
2005	0.7	0.5	0.4	0.4	0.4	0.4	0.4	0.3	0.2	-0.1	-0.4	-0.7
2006	-0.7	-0.6	-0.4	-0.1	0.1	0.2	0.3	0.5	0.6	0.9	1.1	1.1
2007	0.8	0.4	0.1	-0.1	-0.1	-0.1	-0.1	-0.4	-0.7	-1	-1.1	-1.3
2008	-1.4	-1.4	-1.1	-0.8	-0.6	-0.4	-0.1	0	0	0	-0.3	-0.6
2009	-0.8	-0.7	-0.5	-0.1	0.2	0.6	0.7	0.8	0.9	1.2	1.5	1.8
2010	1.7	1.5	1.2	0.8	0.3	-0.2	-0.6	-1.0	-1.3	-1.4	-1.4	-1.4
2010				0.0	0.0		0.0	2.0			2.7	
2011	-1.3			test ON								

Warm Episodes - El Niños: ONI +0.5 and above (red numbers)

Cold Episodes - La Niñas: ONI of -0.5 and below (blue numbers)

Neutral or non-ENSO Episodes: ONI above -0.5 and below 0.5 (black numbers)

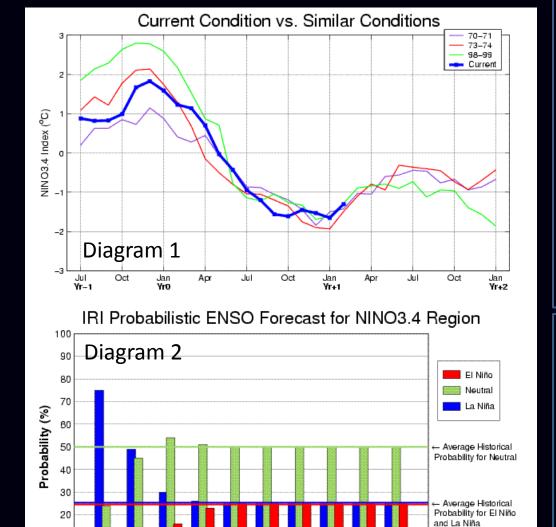
#### Pacific Region Niño 3.4 ENSO Outlook



- All 23 dynamical and statistical ENSO models continue to forecast further weakening of the negative SST anomalies across the eastern tropical Pacific region Niño 3.4 during the next several months. A majority of the models indicate ENSO neutral (+0.5 C to -0.5 C) conditions by the start of the 2011 summer season.
- Beyond this spring, the models offer a wide range of possibilities; some indicate a weak La Niña, others indicate ENSO-neutral conditions, while others suggest weak El Niño conditions.

Source: International Research Institute for Climate and Society (IRI) – Updated 3/17/11

#### La Niñas - Past, Present and Future



Source: International Research Institute for Climate and Society (IRI) – Updated 3/17/11

ASO

Time Period

JAS

10

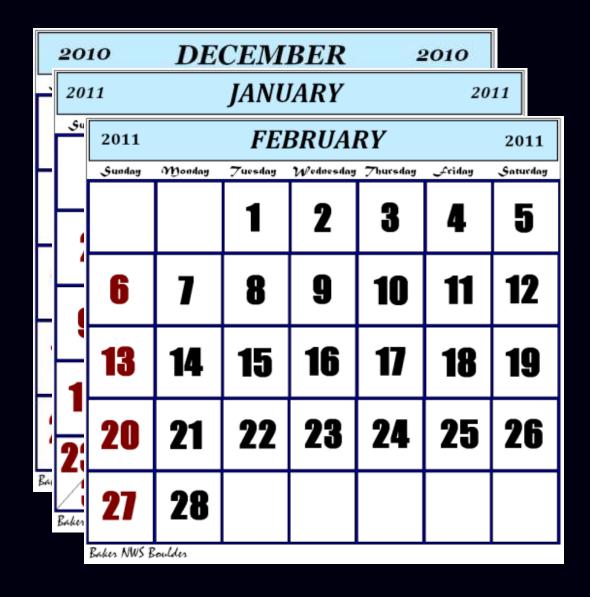
<u>Diagram 1</u>: Shows a comparison of the current La Niña episode to the last four strongest La Niña episodes observed in 1970-71, 1973-74, 1998-99 and 2007-08.

The current La Niña continues to track closely to the previous moderate to strong La Niñas. As of the first of February only the 1973-1974 La Niña was comparatively stronger by only a small margin to the current La Niña. Should the current La Niña perform like those compared to in diagram 1, we would presumably return to weak La Niña conditions by this fall.

Diagram 2: The bar graph depicts the probability of El Niño, La Niña and ENSO-neutral conditions in Pacific Niño Region 3.4 during the next 12 months, based on the latest ENSO model forecasts.

By the summer season of June-July-August, models indicate equal chances for La Niña and El Niño conditions, with no clear preference towards warming or cooling in the SSTs during the remainder of 2011.

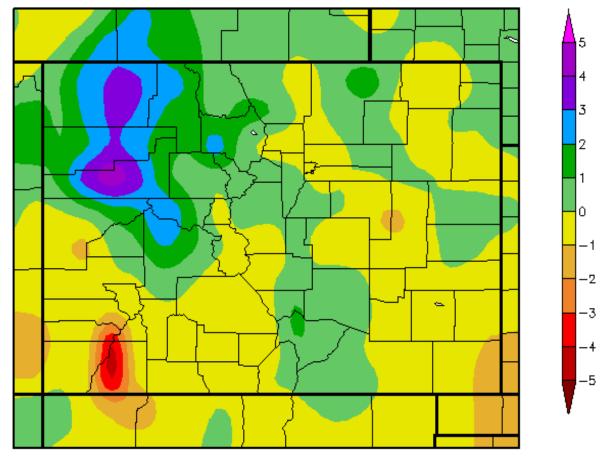




90-Day Review of Temperature, Precipitation, **Snow Pack and Snow-Water** Equivalency Across Colorado

## Departure from Normal Preciptation (in inches) For Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

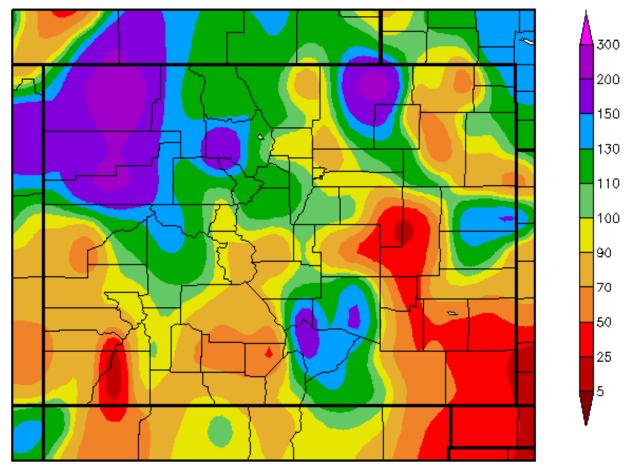
Regional Climate Centers

Above normal precipitation fell across much of northwest and west central Colorado during this three month period, with the greatest departures from normal on the Roan Plateau, Grand Mesa, the West Elk Mountains and the Yampa River Valley.

Below normal precipitation was observed in most of southern and eastern Colorado during the same period. The greatest departure from normal was observed in the Animas River Valley on the south slope of the San Juan Mountains in southwest Colorado.

## Percent of Normal Precipitation (%) for Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 2/11/2011 at HPRCC using provisional data.

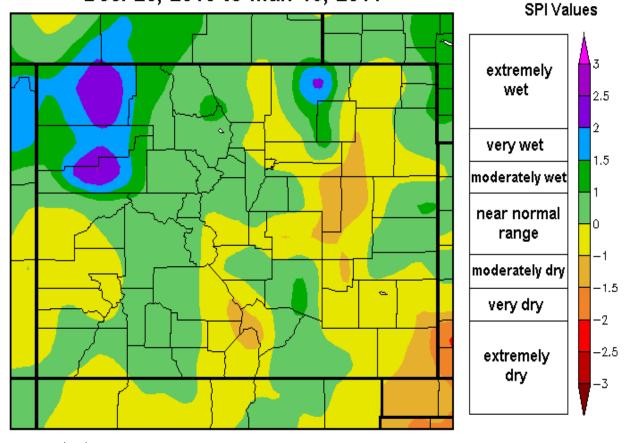
Regional Climate Centers

The northwest corner of Colorado continued to record the greatest percent of normal precipitation during the three month period as indicated by the shades of purple across the region.

The remainder of the state witnessed modest to significant departures from normal precipitation, with the southeast portion of the state recording the greatest deficits.

## 3-Month Standardized Precipitation Index (SPI) for Colorado

Dec. 20, 2010 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

#### The Standardized Precipitation Index (SPI)

was developed to
monitor potential short term
agricultural and
long-term hydrological
drought conditions. The
SPI is a probability index
that considers only
precipitation.

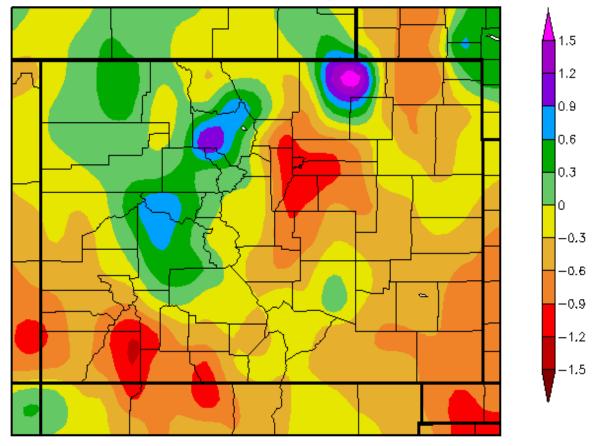
During the 90-day period ending March 19, 2011, the SPI continued to indicate wetter than normal conditions across the northwest, west central and north central portions of the state. The driest conditions persisted east of the Continental Divide, namely along the Palmer Divide east of Denver, the Sangre de Cristo Mountains and the far southeast plains.

201	1		FEBR	UARY		2	011	
Sun	2011		M	ARCI	Н		2011	
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Baker i	27	28	29	30	31			
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30-Day Review of Temperature, Precipitation, **Snow Pack and Snow-Water** Equivalency Across Colorado

## Departure from Normal Precipitation (in Inches) for Colorado

Feb. 18 to Mar. 19, 2011



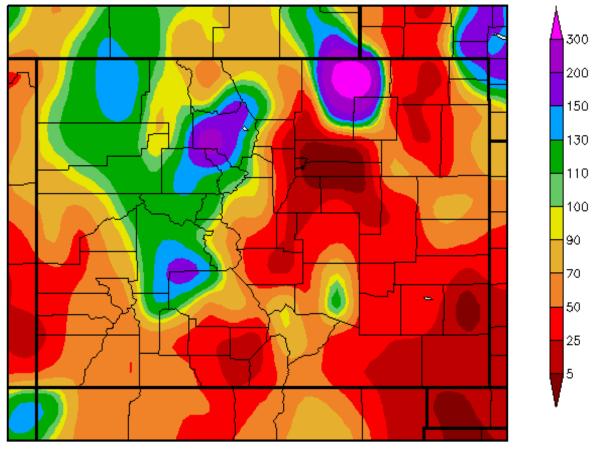
Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

Precipitation, predominantly in the form of snow, continued to run above average across northwest and west central Colorado for the fourth consecutive month. Positive departures from normal decreased, in some areas significantly, from totals observed during the previous 30-day period.

Eastern and southern
Colorado continued to fall
behind in precipitation with
deficits ranging as much as 1.0
to 1.5 inches in the San Juan
Mountains and nearby river
valleys, and in the southern
Front Range/Rampart Range/
Pikes Peak region in east
central Colorado.

## Feb. 18 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

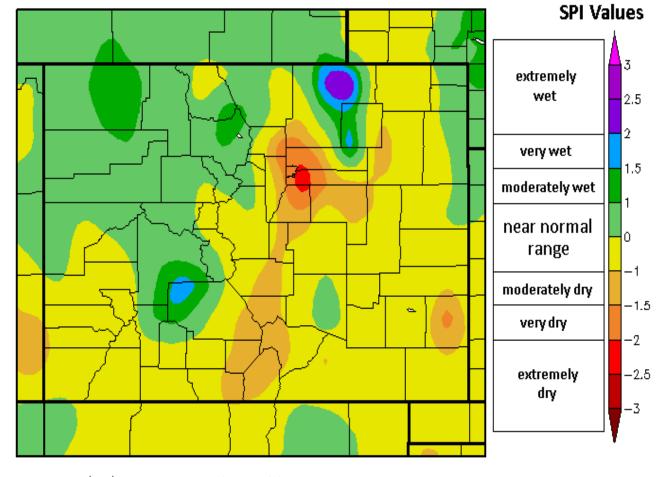
During the 30-day period ending March 19, 2011, precipitation varied from 130 to 300 percent above normal across northwest and west central Colorado.

A second area of above normal precipitation was centered in Weld County in northeast Colorado – a result of a significant snowfall in early March.

Below normal precipitation occurred over the rest of the state with deficits as much as 50% below normal along the Front Range, lower portions of the South Platte River Valley, the Arkansas River Valley in southeast Colorado, and the San Luis Valley in south central Colorado.

## 30 Day Standardized Precipitation Index (SPI) for Colorado

Feb. 18 to Mar. 19, 2011



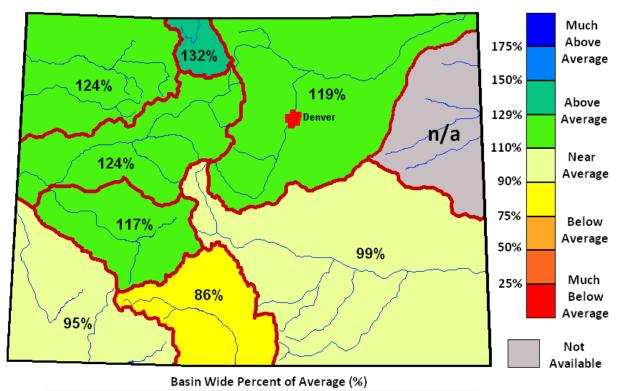
Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Centers

During the 30-day period ending March 19, 2011, the SPI continued to indicate wetter than normal conditions across northwest and west central Colorado, together with portions of northeast Colorado near the Wyoming border, the result of a heavy snowfall in early March.

The remainder of the state, according to the SPI, was either near normal to moderately dry, with the exception of areas along the east slope of the Front Range in northeast Colorado where extremely dry conditions were indicated.

#### Snow Water Equivalent as a Percent of Average (%) for Colorado by River Basin as of Tuesday March 15, 2011



WEST SLOPE	EAST SLOPE
Yampa and White River Basins	Laramie & North Platte Basin
San Migual, Dolores, Animas & San Juan River Basins 95% Upper Rio Grande Basin	Statewide Avg113%

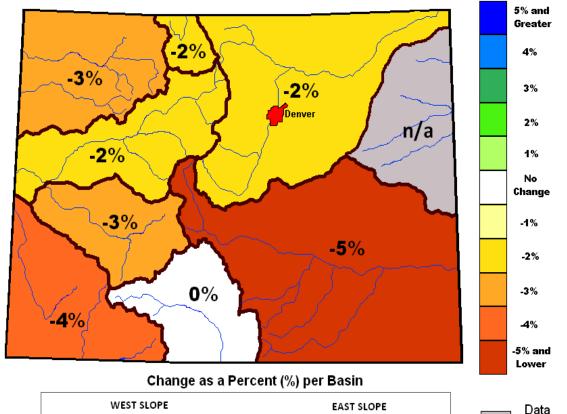
Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon provisional data, subject to revision

#### **Snow Water Equivalents**

remained well above average for the major river basins in northwest and west central Colorado during this 30-day period. Snow water equivalents also remained above average at higher elevations of the South Platte River Basin in northeast Colorado.

Conversely, river basins in southwest, south central and southeast Colorado lost ground due in part to a lack of snowfall, and warmer than average temperatures resulting in greater rates of melting, sublimation and evaporation.

#### Change in Snow-Water Equivalent by Percent Per Colorado River Basin From February 17 to March 15, 2011



WEST SLOPE Yampa and White River Basins			· / /
Upper Colorado River Basin2% South Platte River Basin2% Gunnison River Basin5% Arkansas River Basin5% San Migual, Dolores, Animas & San Juan River Basins4%	WEST SLOPE		EAST SLOPE
	Upper Colorado River Basin	-2% -3% -4%	South Platte River Basin2%

Source: USDA Natural Resources Conservation Service--Water and Climate, Portland, Oregon provisional data, subject to revision

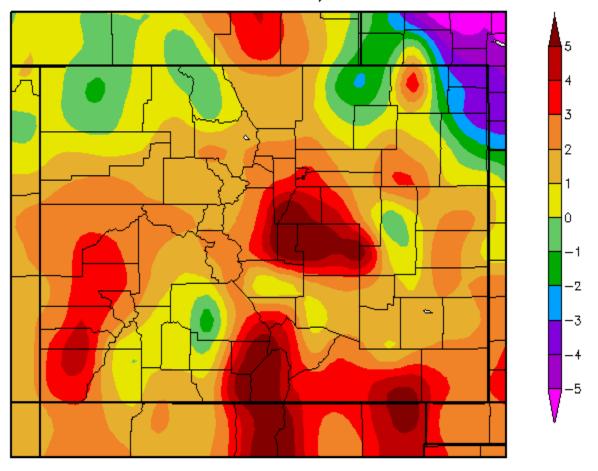
### **Snow Water Equivalents**

decreased in the all major river basins of Colorado during the period February 17 to March 15, except in the Rio Grande Valley where the valley averaged snow water equivalent remained unchanged.

Not A∨ailable

## Departure from Normal Temperature (°F) for Colorado

Feb. 18 to Mar. 19, 2011



Generated 3/20/2011 at HPRCC using provisional data.

Regional Climate Center

**Temperatures across** Colorado during the 30day period ending March 19, 2011, resumed the warming trend observed earlier in the winter, particularly in the San Juan Mountains and the **Four Corners region in** southwest Colorado, the Palmer Divide/Rampart Range/Pikes Peak region in east central Colorado, and the Sangre de Cristo **Mountains and Raton** Pass region in southern Colorado.

The northwest plateau and Yampa River Valley region continued to experience colder than average temperatures, as well as the far northeast corner of the state.

Even as La Niña weakens, it may still continue to influence weather patterns across Colorado during the remainder of the 2011 spring season.





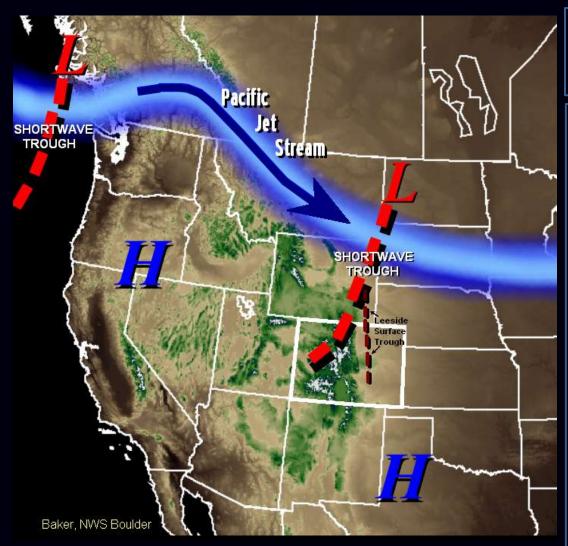


Unseasonably warm and very dry conditions produced by gusty Chinook winds are usually necessary for elevating the wildland fire danger to critical levels in eastern Colorado.

Colorado may continue to feel the effects of a strong westerly or zonal flow aloft for at least another month as La Niña gradually loses its strength. Waves of moist Pacific air carried along by a ribbon of strong westerly winds aloft (e.g., the Pacific Jet Stream) will likely continue to produce periods of moderate to heavy mountain snowfall, on progressively higher west facing mountain slopes as temperatures rise through at least the end of April. While at the same time, this prevailing zonal flow pattern will also continue to generate periods of abnormally warm and very dry weather, accompanied by potentially damaging downslope (Chinook) wind events in areas east of the Continental Divide.

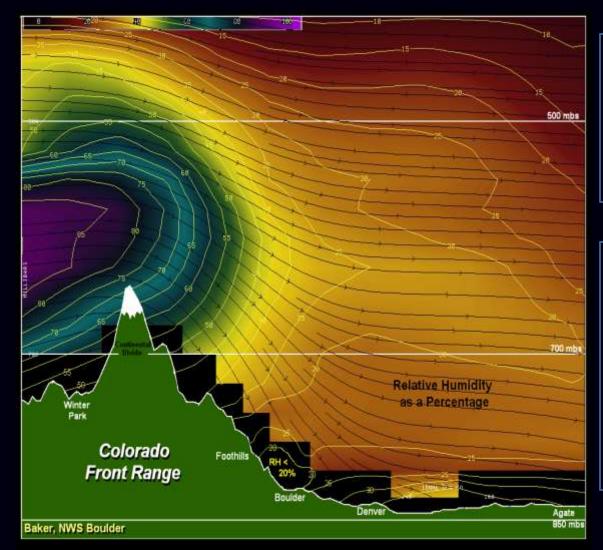
Such as flow pattern also produces gusty and at times strong southwest winds in the San Luis Valley. Locals refer to these stiff winds during the spring as "sand dune building" winds, in reference to the Great Sand Dunes National Park.

#### The Seasonal Shift in the Jet Stream



As La Niña continues to weaken, so too will the Pacific jet stream as it slowly migrates to higher latitudes.

Strong warming in the desert southwest and across the Great Basin beneath a broad ridge of high pressure aloft should shift the Pacific Jet Stream northward over the Pacific Northwest and southwest Canada during the coming weeks. Weather disturbances embedded within this ribbon of strong winds aloft are likely to dive southward across Wyoming and northern Colorado from time to time, bringing rain and snow possibly heavy to the mountains and high valleys of northwest and north central Colorado, and strong and gusty west- northwest winds to the Front Range adjacent plains of eastern Colorado.



Winds down sloping off the Front
Range typically produce very low
relatively humidities and
abnormally warm temperatures in
areas adjacent to the Front Range,
regardless of the time of day.

RH values of less than
ten percent are not that uncommon
with these katabatic type winds. The
influence of these often gusty and
erratic winds may only extend a
handful of miles onto the plains. For
instance, RH could rise from 5
percent to 30 percent in a distance
of only 10 miles!

#### Potential Impacts on the Colorado Front Range During the Final Days of La Niña



**Record Heat** 



A Growing Risk of Wildland Fires



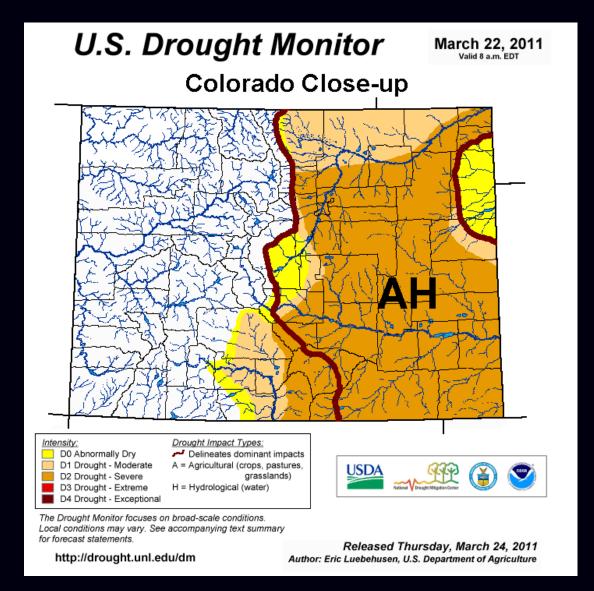
Abnormally Dry
Conditions
Leading to Serious
Drought



Drastically Reduced Runoff to Area Lakes and Reservoirs



Strong and Potentially Damaging Downslope Wind Storms



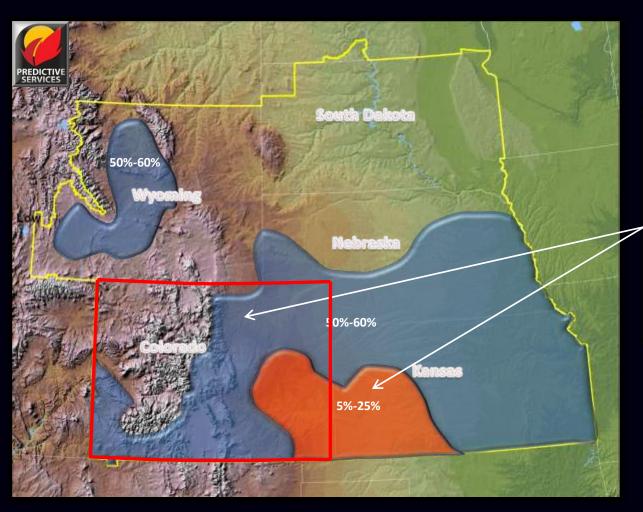
According to the U.S. Drought Monitor, moderate (D1) to severe (D2) drought conditions cover essentially all of eastern Colorado as of the 22<sup>nd</sup> of March. Dominant impacts include both agricultural and hydrological interests.

Abnormally dry (D0) to moderate (D1) drought conditions also exist in the San Luis Valley of southern Colorado, along the east facing slopes of the San Juan, La Garita, Rampart and Front Range mountains, and across the far northeast corner of the state.



## **Rocky Mountain Area**

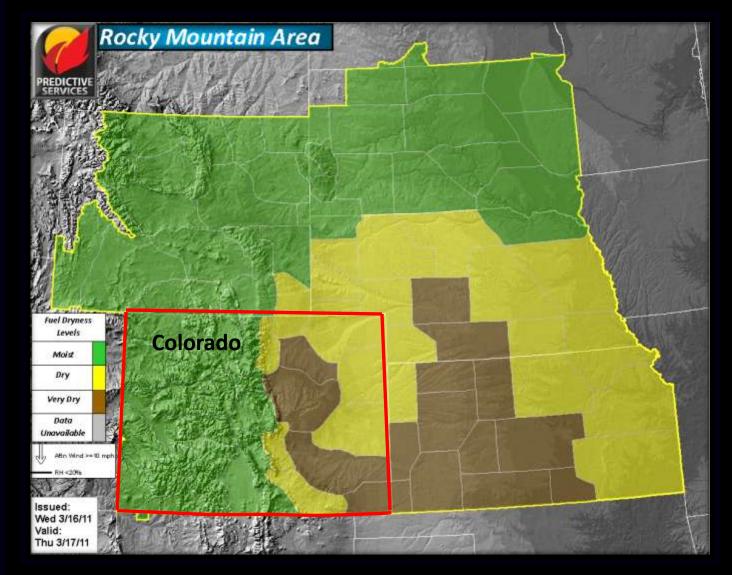
6-Month Percent of Average Precipitation



Dry Period
Began Late
Summer 2010

50%-60% Average
5%-25% Average

The following Predictive Services maps were provided by Tim Mathewson – BLM/RMCC GACC Meteorologist, Lakewood, Co

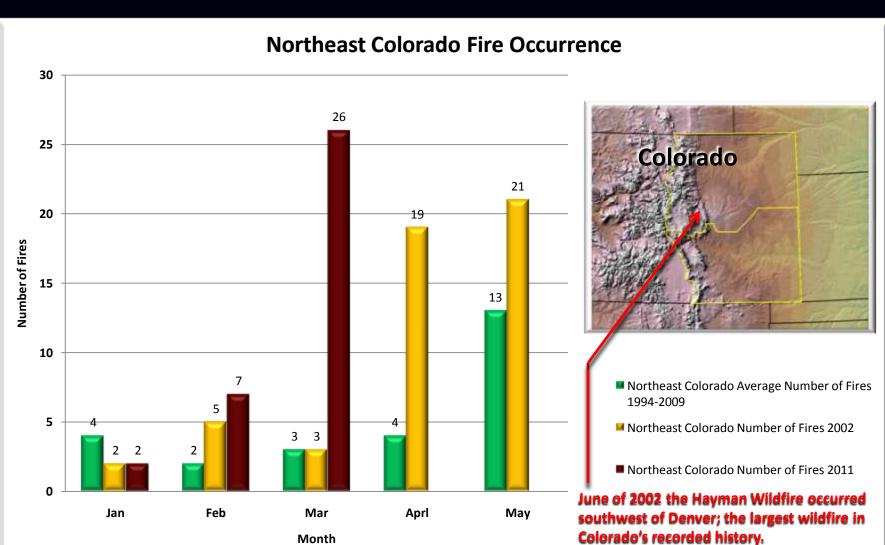


Fuels such as short and tall grasses and shrubs have continued to dry out across eastern Colorado due in large part to the recent abnormally dry, warm and windy conditions. As of mid-March, Predictive Services in Boise, Idaho indicated a wide area of dry to very dry fuels from the Colorado Front Range eastward across Kansas and Nebraska to the Missouri River.

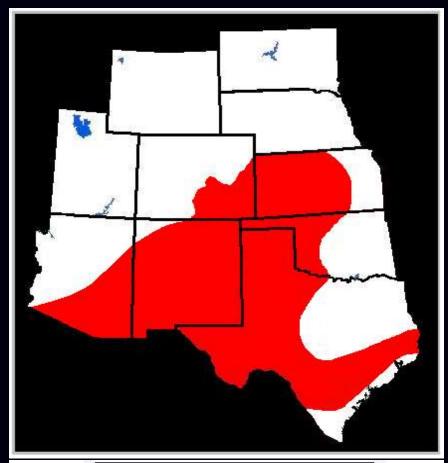


### **Rocky Mountain Area**

1994-2009 Fire Occurrence



#### Seasonal Significant Wildland Fire Potential Outlook - April to June 2011



Predictive Services at the National Interagency Coordination Center in Boise, Idaho predicts that the potential for significant wildland fire will persist across southeast Colorado through the remainder of this spring.

Other parts of Colorado, such as the northeast plains and the San Luis Valley, may also see the potential for significant wildland fire increasing during the coming weeks should the abnormally warm and dry weather conditions persist.

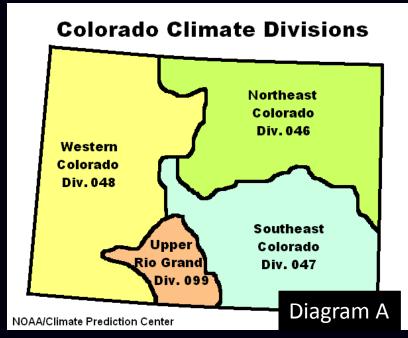


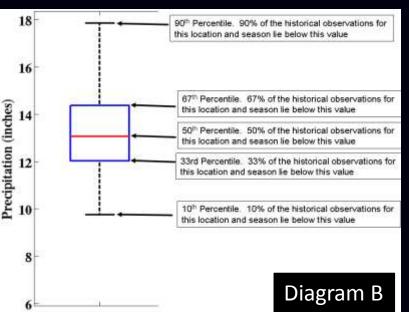
of additional resources from outside the area in which the fire situation originates.





Map produced by Predictive Services, National Interagency Coordination Center Boise, Idaho Issued February 1, 2011 Next issuance March 1, 2011





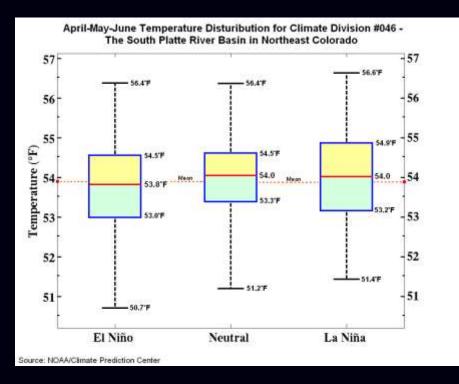
**Diagram A:** Colorado is sub-divided into four climate divisions. Climate divisions 046, 047 and 099 are located east of the Continental Divide.

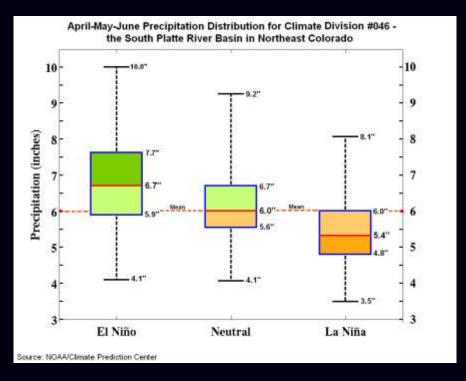
NOAA's Climate Prediction Center (CPC) has produced historical distributions of 3-month temperature and precipitation associated with three different ENSO categories – El Niño, La Niña and neutral (non-ENSO) events – for each of climate division.

<u>Diagram B</u>: These historical temperature and precipitation distributions can be viewed using an ENSO box and whisker analysis plot (explanation to the left).

The red line inside the ENSO box represents the mean or 50<sup>th</sup> percentile of the data (temperature or precipitation) distribution. Approximately 34% of the total observations exist within the ENSO box, and the remaining observations (or 66%) outside of the box.

## ENSO Box and Whisker Analysis Plots for Climate Division #046 – The South Platte River Basin in Northeast Colorado for the 3-Month Climate Season of April-May-June





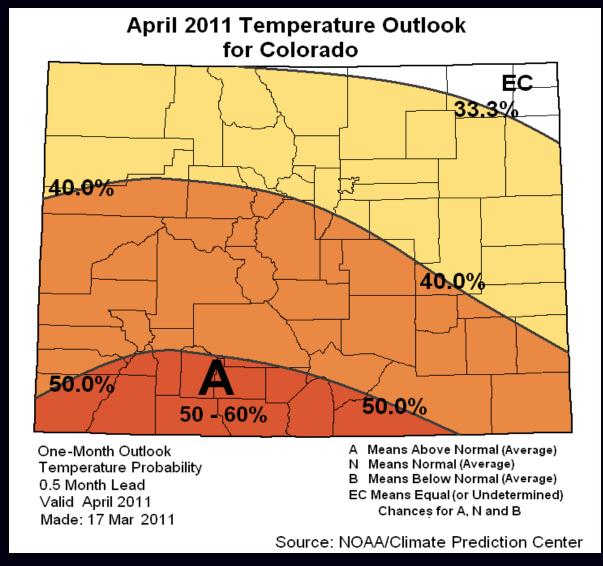
The three temperature plots in the left diagram reveal little discernible difference in the historical distribution of temperature during the months of April, May and June. However, it could be argued that the total range in temperatures for climate division #046 was slightly warmer during La Niñas than were observed during El Niño and neutral (non-ENSO) events.

The difference in the distribution of precipitation during El Niño, La Niña and neutral events is more apparent. The three plots above show that the 3-month climate season April-May-June for Colorado climate Division #046 was significantly drier during earlier La Niñas compared to that observed during past El Niño and neutral events.

# Temperature and Precipitation Outlooks For April-May-June 2011 Issued by NOAA's Climate Prediction Center



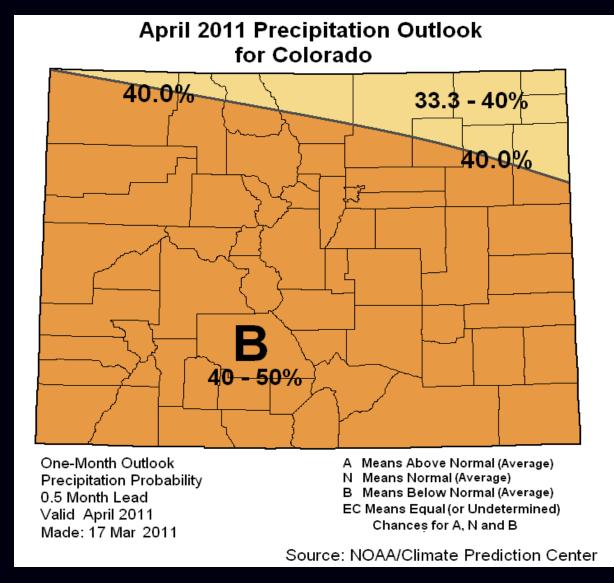




## Trending Towards Warmer and Drier Conditions, Especially Across Western Colorado

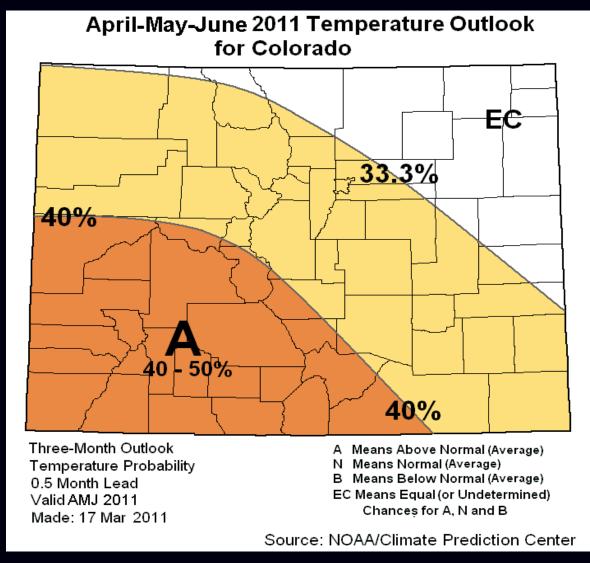
The expected shift to warmer than normal temperatures on the western slope of Colorado could accelerate the melting of an abnormally deep snowpack, possibly resulting in unusually high runoff into area water ways.

For April, the outlook from CPC is for at least a 50% chance of above normal (average) temperature in an narrow area along the New Mexico border including southern portions of the San Juan Mountains, a 40 to 50% chance of above average temperature across central portions of Colorado, and a 33.3 to 40% chance of above temperature for the remainder of the state. The extreme northeast of the state the outlook is less uncertain as indicated by EC.



CPC's confidence in their outlook for below average precipitation across Colorado has increased, especially across southern and western part of the state. This expressed confidence in their forecast may be attributed to the expected northward displacement of the storm track (the Pacific Jet Stream) with the formation of a strong blocking high pressure ridge over the western continental United States in the next few weeks.

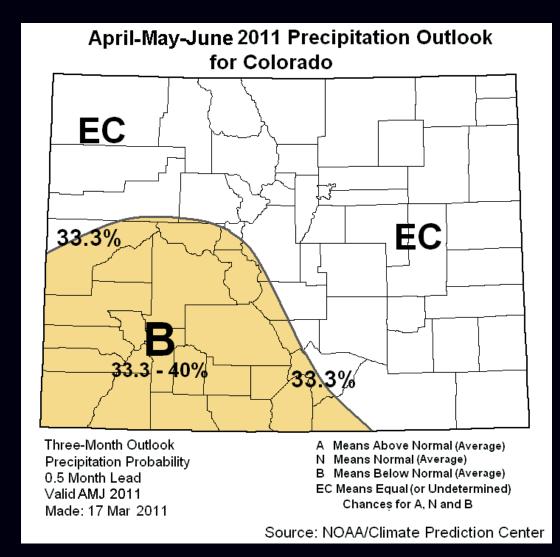
The outlook from CPC is for a 40 to 50% chance of below normal (average) precipitation for all except the northeast corner of Colorado during April. In the far northeast corner of the state, the outlook is for only a 33.3 to 40% chance of below average precipitation.



The uncertainty (EC) in the temperature outlook for the northeast corner of the state may be attributed to a strong northwest oriented Pacific Jet Stream (storm track) in the area later this spring.

A strong northwesterly jet stream flow over northeast Colorado during the springtime has been blamed for all types of wild weather—ranging from damaging hail storms, surprise snow squalls, powerful thunderstorm winds, to even tornadoes. Local weather forecasters are sometimes heard uttering the phrase "beware of northwest flow," when this highly sheared flow pattern is expected to develop.

The outlook for April, May and June from CPC is for a 40 to 50% chance of above normal (average) temperature across the southwest one-quarter of Colorado, a 33.3 to 40% chance of above average temperature across the northwest, central and southeast parts of the state, and an equal or undetermined chance for above, below or near average temperature across the northeast corner.



The symbol EC is often used by CPC to express an equal chance for above, below and near normal precipitation or temperature. It may also denote a degree of uncertainty in the outlook.

As the ENSO signal weakens and becomes indistinguishable from "usual" climate drivers (i.e., the seasons, day length, etc.) the ability to assign either above, below or near normal to an outlook become somewhat more difficult.

For this three month period, the outlook from CPC is for a 33.3 to 40% chance of below normal (average) precipitation across the southwest one-quarter of Colorado, and an equal chance of above, below and near average precipitation across the remainder of the state.

#### **Summary**

- La Niña continues to weaken in the central and eastern tropical Pacific Ocean as indicated by the recent warming of sea surface temperatures anomalies in the region.
- The latest forecasts, from nearly two dozen ENSO-climate models, continue to indicate an equal chance of ENSO-neutral and weak La Niña conditions in the tropical Pacific Ocean by late this spring.
- Even as La Niña continues to weaken, it is possible that it will continue to play an important role on local weather patterns across Colorado throughout this spring. Impacts from these weather anomalies include producing significant wildland fire danger, particularly in areas east of the Continental Divide and the potential for heavy runoff from rapid mountain snow melt in areas west of the Divide.
  - The latest outlook prepared by NOAA's Climate Prediction Center (CPC) indicates better than a 33% chance of above normal (average) temperature and below normal (average) precipitation across nearly all of the Colorado during the months of April, May and June of 2011. Most notable change in this latest outlook is the shift to warmer and drier conditions west of the Continental Divide.



